

Method and system for controlling the addition of  
oxygen gas and alkali during oxygen gas  
delignification

### Technical Area

The present invention concerns a method and a system for controlling the addition of the delignification chemicals oxygen gas and alkali during the oxygen  
5 gas delignification of cellulose pulp as described in the introductions to claims 1 and 7.

### The Prior Art

A number of methods for the addition of a suitable amount of oxygen gas and alkali during oxygen gas delignification are known:

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One method is to measure the kappa value (or the lightness) of the cellulose pulp before the oxygen gas stage, and a correction of the amounts added is based on the current reduction in kappa value during the oxygen gas stage. Measurement of the kappa value is carried out following a standard on "clean"  
15 (washed) cellulose pulp and a sample for measurement of the kappa value is taken after the wash that precedes the oxygen gas delignification. A correction of the amounts of delignification chemicals is often necessary, since precipitated lignin and additional active substances accompany the cellulose pulp. This is particularly true if problems have arisen with the preceding wash before  
20 the oxygen gas delignification or if dilution of the pulp before the delignification takes place with a filtrate having an uneven or a high content of oxidisable material and/or other organic material.

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The measurement of the kappa value on-line is often used, but these systems are expensive, since the pulp is washed and requires accurate calibration. The  
25 measurements of kappa value are carried out at positions before and after the oxygen gas stage, normally at an interval between measurements of 1-4 times per hour.

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The commonly used method of adjusting the pH is to measure the pH at the  
30 end of the delignification process and subsequently to correct it by the addition of alkali at the start of the process. This method, however, can only be used as

a method of feed-back control, and then with a time delay of approximately 60-180 minutes, which corresponds to the retention time of the pulp in the system. Furthermore, the measurement of pH relates to the amount of added alkali that is required, and only indirectly to the amount of required oxygen addition.

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Two temperature measurements are currently carried out in association with oxygen gas delignification. The first is carried out at the start of the delignification, and the second at the end of the delignification. The aim of these temperature measurements is to ensure that the pulp has the correct temperature as it passes through the delignification process.

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#### Aim and Purpose of the Invention

The principal aim of the present invention is to offer a more optimal charge of delignification chemicals during oxygen gas delignification of cellulose pulp in a gas/fluid suspension, where the oxygen gas delignification takes place in a reactor system stage with at least one oxygen gas reactor. This is achieved according to the invention through the characteristics specified in claims 1 and 7. In this way, a better and a more even delignification is achieved, since the correct quantities of bleaching chemicals can be charged without a long time delay. This results in a much easier control of subsequent bleaching stages since the input pulp achieves a stable kappa value.

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By coupling a measured increase in temperature at the beginning of the delignification process to a theoretical consumption of quantities of oxygen and alkali in the process, a rapid compensation in the charged amount of bleaching chemicals can be carried out. This ensures the presence of oxygen gas during the complete delignification process of the pulp. The charged amount of oxygen gas can in this way be reduced to a minimum, adapted to the instantaneous requirement; and excess charges of chemicals to compensate for normal variations in the pulp suspension can be avoided. This leads to a reduction in the operating costs.

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#### Description of Drawings

Figure 1 shows schematically parts of a system for oxygen gas delignifica-

tion in which the method according to the invention is applied.

Figure 2 shows the difference in oxygen gas trends between a reaction in which oxygen gas reacts with released lignin, lignin in the pulp fibres and additional active substances; and a reaction in which oxygen gas reacts only with the lignin in the pulp fibres.

Figure 3 shows the difference in the derivatives between a reaction in which oxygen gas reacts with released lignin, lignin in the pulp fibres and additional active substances; and a reaction in which oxygen gas reacts with the lignin in the pulp fibres.

#### 10 Detailed Description of Preferred Embodiments

A method according to the invention is shown in Figure 1 in the form of a system for the oxygen gas delignification of cellulose pulp in a gas/fluid suspension, in which oxygen gas delignification takes place in a reactor system with at least a first oxygen gas reactor 101 and a second oxygen gas reactor 102. The delignification process is preceded by a wash 103 with the aim of cleaning the cellulose pulp from released contaminants such as released lignin and additional active substances. The pulp on output from the wash is often dewatered to consistencies of 25%-40%, and this dewatered pulp is most often diluted with a filtrate that is supplied from a subsequent bleaching stage or from the washing stage after the oxygen gas stage. This filtrate can vary, depending on the subsequent bleaching stages, with respect to the contents of released organic material. The pulp is transported following the washing stage 103 into a storage tower (or fall pipe) 104 in which a quantity of alkali is added that normally ensures the expected pH of greater than 9 in the final reactor. A pump 105 in association with the storage tower/fall pipe 104 fluidises the pulp such that it can be pumped, and ensures an efficient mixing of the alkali into the pulp. Oxygen gas is subsequently added in an arranged first mixer 106 at such an amount that residual oxygen gas is present during the complete reaction process in the reactors.

30 The first reactor 101 typically has a shorter retention time than the second reactor 102 and the first reactor is followed by a second mixer 107 for remixing of the pulp and addition of oxygen gas and steam. The remixing is required in order to obtain renewed mixing of the pulp and even distribution of residual

chemicals in the pulp, since principally the oxygen gas has a tendency to collect in large gas bubbles where it does not achieve an even effect throughout the pulp suspension. Oxygen gas can be added during this remixing, together with steam in order to heat the pulp before the final stage.

- 5 Once the pulp has passed the reactor system, the pulp is fed to a blow tank 108 that is connected through valves to the atmosphere.

A pH sensor 109 is located at the top of the second and/or the final reactor 102, arranged to ensure that the pH does not fall below the threshold value. This pH sensor controls subsequently the charged amount of alkali to the storage

- 10 tower/fall pipe 104.

In systems with only one pump 105, the second reactor 102 is pressurised at a pressure that is somewhat lower due to natural losses of pressure fall throughout the system. If it is desired to compensate partially or fully for loss of pressure in the system, a reinforcing pump 110 can be incorporated. It is also possible to use a small first reactor (with a retention time of 5-15 minutes) with an attached large reactor that is maintained at a higher temperature and pressure than the first reactor.

- 20 According to the invention, the temperature of the cellulose pulp is measured at at least two different positions ( $T_1$ ,  $T_2$ , ...,  $T_n$ ) at the beginning of the oxygen gas delignification process, when viewed in the direction of flow of the cellulose pulp through the system. The term "beginning" is here used to denote the execution of at least two measurements located after each other in the oxygen gas delignification system before the pulp has had a retention time between the measurements of less than 50% and preferably less than 30% of the total retention time in the oxygen gas delignification system. Since the pulp is in motion in the direction of flow, the pulp that passes  $T_1$  at time  $t_1$  will pass  $T_2$  at time  $t_2$ , etc., up to position  $n$ . The number of positions,  $n \geq 2$ .

- 25 The positions between two subsequent temperature measurements are equivalent to positions between which the pulp has had a retention time in the system of between 5 seconds and 30 minutes, preferably between 1 minute and 10 minutes. The first temperature measurement  $T_1$  is measured at a position in association with the addition of oxygen gas 106, either before or, preferably, directly after the addition of oxygen gas. The temperature measurements are
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used to control or adjust the charged amount of at least one delignification chemical to the oxygen gas delignification. The temperature measurements show the magnitude of the increase in temperature that has taken place as a consequence of the exothermic reaction of the oxygen gas. The relevant retention time between the measurements can be derived directly from the current flow of pulp and the volumes of pipes and reactors. The increase in temperature can, in turn, be related to the consumption of oxygen gas. Since the consumption of oxygen gas is initially principally related to the oxidation of released lignin and additional active substances in the fluid phase, and not to the slower reaction of lignin in the fibres, an accurate correction of the amount of oxygen gas added can be carried out, depending on the amount of oxidisable material in the fluid phase. By measuring the temperature difference between T1 and subsequent measurements, it is possible to determine the quantity of oxygen gas that has been consumed and then control, principally, the addition of oxygen gas, and, secondarily, the addition of alkali.

At least two measurements T1 and T2 are carried out in a second embodiment. By studying the derivative, i.e. the gradient, of the line between the first and the second temperature measurement, an estimate can be obtained of the addition of oxygen gas that is necessary. Figure 3 makes clear how such a method can work. The full line 301 in Figure 3 corresponds to a reaction in which oxygen gas reacts with released lignin and additional active substances, the dashed line 302 corresponds to a reaction in which oxygen gas reacts with the lignin in the fibres. Thus, the derivative can be used to control, primarily, the addition of gas and, secondarily, the addition of alkali.

In a further preferred embodiment, the temperature measurements are coupled with a temperature trend, which in turn corresponds to an oxygen gas trend. The oxygen gas trend shows the consumption of oxygen as a function of time. Figure 2 shows how such an oxygen gas trend may appear. By studying the oxygen gas trend, it is possible to determine whether the oxygen gas has been used by the rapid reaction with released lignin and additional active substances in the fluid phase or by the slower reaction in which oxygen gas reacts with lignin in the fibres, which latter reaction is normally measured using the kappa value. The full line 201 in Figure 2 corresponds to a reaction in which oxygen

gas reacts with released lignin and additional active substances, the dashed line 202 corresponds to a reaction in which oxygen gas reacts with the lignin in the fibres. The oxygen gas trend can thus be used to control, primarily, the addition of oxygen gas and, secondarily, the addition of alkali.

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When measuring the temperatures T1, T2, ..., Tn in the embodiments described above, sensors 113 are used, which may be arranged after each other in the direction of flow of the pulp with a physical location in the system that gives a retention time of 5 seconds to 30 minutes, preferably 1-10 minutes. The sensors 113 transfer the measured data via means for signal transfer to a suitable control unit 111. The control unit 111 processes the measured data from the sensors and calculates how much oxygen has been consumed during the exothermic process. The control unit 111 subsequently controls a signal-controlled valve 112 to regulate the amount of added oxygen gas.

The principal advantages of the system relative to the prior art for the charge of delignification chemicals during the oxygen gas delignification of cellulose pulp in a gas/fluid suspension are the following:

- A more optimal charged amount of delignification chemicals
- Better and more even delignification
- More rapid compensation in the amount of bleaching chemicals charged
- Reduced operating costs.

The invention can, naturally, be used also for any one of the subsequent reactors in an equivalent manner as that shown above for the first reactor.

The invention is not limited to the embodiments revealed here; several variants are possible within the scope of the patent claims. For example, the invention can be supplemented with a self-learning system, in which matches are made during the learning phase between temperature profiles and the charge of chemicals using the pH that is obtained in the outlet or using on-line measurements of the kappa value using suitable sensors.

The first temperature measurement can take place also in the pulp chute that is placed in the flow before both the pump and the first oxygen gas mixer, and where the increase in temperature caused by the pumping/mixing is negligible.

5 The second temperature measurement can take place also in the inlet nozzle of the first reactor, anything to guarantee a certain retention time between measurements of the flow of pulp. The measurements in the reactor can be misleading in certain cases, if the flow of pulp occurs in channels, or if a poor quality pulp distributor is located in the inlet to the reactor.